UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

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OSAMU YAMADA ET AL.	
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APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
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1. [X] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification — *Total Pages* 42
3. [X] Drawing(s) *(35 USC 113)* — *Total Sheets* 15
4. [X] Oath or Declaration — *Total Pages* 2
   - a. [ ] Newly executed (original or copy)
   - b. [X] Unexecuted for information purposes
   - c. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
     - i. [ ] DELETION OF INVENTOR(S) Signed Statement attached deleting inventor(s) named in the prior application, see 37 CFR 1 63(d)(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4c is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4c, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy
   - b. [ ] Paper Copy (identical to computer copy)
   - c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [ ] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
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17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*
[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No. __/______

18. CORRESPONDENCE ADDRESS

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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	32-20 =	12	X $ 18.00 =	$216.00
	INDEPENDENT CLAIMS (37 cfr 1.16(b))	3-3 =	0	X $ 78.00 =	$0
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			$260.00 =	$
				BASIC FEE (37 CFR 1.16(a))	$760.00
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	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				
				TOTAL =	$976.00

19. Small entity status
    - a. ☐ A Small entity statement is enclosed
    - b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
    - c. ☐ Is no longer claimed.

20. ☒ A check in the amount of $ 976.00 to cover the filing fee is enclosed.

21. ☐ A check in the amount of $ __________ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:
    - a. ☒ Fees required under 37 CFR 1.16.
    - b. ☒ Fees required under 37 CFR 1.17.
    - c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
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DATE	October 18, 1999

NY_MAIN 34785 v 1

TITLE OF THE INVENTION

IMAGE PROCESSING APPARATUS AND METHOD, AND RECORDING MEDIUM

BACKGROUND OF THE INVENTION

This invention relates to an image processing apparatus and method for performing saturation conversion.

In general, an image processing apparatus for forming a multi-valued image performs so-called saturation conversion to obtain an image with appropriate saturation by compensating saturation for a less saturated area in an image, and suppressing saturation for an oversaturated area.

In order to implement saturation conversion in a conventional image processing apparatus, saturation values (normally ranging from 0.0 to 1.0) are calculated in units of pixels in an image, and the saturation value of each pixel is corrected by multiplying the saturation value by a predetermined saturation conversion parameter.

However, the conventional image processing apparatus always performs saturation conversion based on a saturation conversion parameter with a constant

value regardless of the image feature of the image to be converted.

In general, of colors that the image processing apparatus can reproduce, the flesh tone of a human being, green of plants, blue of sky, and the like are known as colors that a person especially notices and reacts sensitively to their delicate conversion results. Such colors will be referred to as "memory color" hereinafter. Optimal saturation values of these memory color vary depending on their color types. Hence, impression of an image differs depending on the saturation values of these memory color.

Hence, when a process for simply increasing or suppressing saturation at a given rate for the entire image is done regardless of the presence of memory color in the image as in the conventional apparatus, an image which can give good impression to the user cannot always be obtained. That is, it is desired to change the degree of saturation conversion in correspondence with the presence/absence of memory color in an image, or their color types if they are present.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an image processing apparatus and method, which can implement appropriate saturation

conversion in correspondence with image characteristics, and a recording medium.

According the present invention, the foregoing object is attained by providing an image processing apparatus comprising: characteristic discrimination means for discriminating characteristics of an image; saturation calculation means for calculating saturation information of the image; parameter setting means for setting a parameter used to convert saturation of the image in accordance with the characteristics discriminated by said characteristic discrimination means; and saturation conversion means for converting the saturation of the image on the basis of the parameter.

With this apparatus, the characteristic discrimination means discriminates the image characteristics, the saturation calculation means calculates saturation information of an image, the parameter discrimination means sets a parameter for converting the saturation of the image in correspondence with the characteristics, and the saturation conversion means can convert the saturation of the image on the basis of the set parameter.

The invention is particularly advantageous since saturation conversion can be done in correspondence with the image characteristics.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a block diagram showing the hardware arrangement of an image processing apparatus according to the present invention;

Fig. 2 is a diagram showing an example of the module arrangement of software according to the present invention;

Fig. 3 is a flow chart showing an outline of an image process in the present invention;

Fig. 4 is a table showing an example of data items held by a parameter holding block;

Fig. 5 is a flow chart showing an image attribute discrimination process;

Figs. 6A and 6B are views showing examples of image attribute discrimination results;

Fig. 7 is a flow chart showing a highlight/shadow calculation process;

Fig. 8 is a graph showing an example of a luminance histogram;

Fig. 9 is a flow chart showing a white/black balance calculation process;

Fig. 10 is a flow chart showing an image correction process;

Fig. 11 is a graph showing an example of the characteristics of a look-up table;

Fig. 12 is a flow chart showing a saturation conversion process;

Fig. 13 is a flow chart showing a color space conversion process;

Fig. 14 is a graph showing an example of saturation conversion characteristics;

Fig. 15 is a graph showing an example of saturation conversion characteristics; and

Fig. 16 is a flow chart showing an inverse color space conversion process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

[Apparatus Arrangement]

An example of the arrangement of an image processing apparatus according to an embodiment of the present invention will be described in detail hereinafter with reference to the accompanying drawings. Note that the image processing apparatus of the present invention is implemented by an apparatus comprising the hardware arrangement (e.g., a computer apparatus such as a personal computer), as shown in, e.g., Fig. 1, or by supplying software having functions (to be described later) to a dedicated computer apparatus.

Referring to Fig. 1, a CPU 102 of a computer apparatus 100 executes a program stored in a ROM 101 or storage unit 108 such as a hard disk or the like using a RAM 103 and the storage unit 108 as a work memory. The program includes at least an operating system (OS) and software for executing processes (to be described later) according to this embodiment.

Image data to be processed by the computer apparatus 100 is input from an input device such as a digital still camera 107 or the like via an input interface (I/F) 106, and is processed by the CPU 102. The processed image data is converted by the CPU 102

into a format corresponding to an output device, and is then sent to an output device such as a printer 111 or the like via an output I/F 110. The input image data, output image data, image data whose processing is underway, and the like can be stored in the storage unit 108 or can be displayed on a monitor 105 such as a CRT, LCD, or the like via a video I/F 104 as needed. These processes and operations can be designated by the user using a keyboard as an input device, a mouse as a pointing device, and the like connected to a keyboard I/F 109.

Note that the input and output I/Fs 106 and 110 can use SCSI as a versatile interface, parallel interfaces such as GPIB, Centronics, and the like, and serial interfaces such as RS232, RS422, IEEE1394, USB (Universal Serial Bus), and the like.

The storage unit 108 can use storage media such as MO, optical disks (e.g., DVD-RAM), and the like in addition to the hard disk. As a device for inputting image data, a digital video camera, image scanner, film scanner, and the like can be used in addition to the digital still camera, or image data can be input from the storage medium or via a communication medium. As a device to which image data is output, printers such as a laser beam printer, ink-jet printer, thermal printer, and the like, a film recorder, and the like can be used.

Furthermore, the processed image data may be stored in the storage medium or may be output onto the communication medium.

[Functional Arrangement]

Fig. 2 is a diagram showing an example of the arrangement of function blocks (modules) of software according to this embodiment. In this embodiment, the functional arrangement that implements saturation conversion in this embodiment comprises an image input block 2, image output block 3, image buffer 4, parameter holding block 5, histogram holding block 6, histogram generation block 7, highlight/shadow calculation block 8, white/black balance calculation block 9, image correction block 10, saturation calculation block 11, saturation conversion parameter setting block 12, saturation conversion block 13, and image attribute discrimination block 15.

The image input block 2 loads an input image 1, and writes it in the image buffer 4. The parameter holding block 5 holds parameters (including saturation conversion parameters) required for correction to be described later. The histogram holding block 6 holds a histogram of image data. The histogram generation block 7 generates a histogram based on image data stored in the image buffer 4, and stores the generated histogram in the histogram holding block 6. The

highlight/shadow calculation block 8 calculates highlight and shadow points on the basis of the histogram stored in the histogram holding block 6, and stores the calculated points in the parameter holding block 5. The white/black balance calculation block 9 calculates white and black balances, and stores them in the parameter holding block 5. The image correction block 10 corrects image data stored in the image buffer 4 on the basis of data stored in the parameter holding block 5.

The image attribute discrimination block 15 discriminates the image attributes of image data stored in the image buffer 4.

The saturation calculation block 11 calculates the saturation of image data stored in the image buffer 4. The saturation parameter setting block 12 determines a saturation conversion parameter on the basis of saturation information of an image and user instruction, and stores the determined parameter in the parameter holding block 5. The saturation conversion block 13 converts the saturation of image data stored in the image buffer 4 using the saturation conversion parameter stored in the parameter holding block 5.

The image output block 3 reads out image data stored in the image buffer 4, and outputs it as an output image 14.

[Outline of Image Process]

Fig. 3 is a flow chart showing an out line of an image process in this embodiment. In step S1, the image input block 2 loads an input image 1, and stores it in the image buffer 4. In step S2, the image attribute discrimination block 15 discriminates the attributes of the image on the basis of the image data stored in the image buffer 4. Note that the operation of the image attribute discrimination block 7 will be described in detail later with reference to Fig. 5.

In step S3, the histogram generation block 7 generates a luminance histogram on the basis of the image data stored in the image buffer 4, and stores the generated histogram in the histogram holding block 6.

In step S4, the highlight/shadow calculation block 8 calculates highlight and shadow points of the image on the basis of the luminance histogram stored in the histogram holding block 6. Note that the operation of the highlight/shadow calculation block 8 will be described in detail later with reference to Fig. 7.

In step S5, the white/black balance calculation block 9 calculates the white and black balances of the image data stored in the image buffer 4. Note that the operation of the white/black balance calculation block 9 will be described in detail later with reference to Fig. 9.

In step S6, the image correction block 10 loads the image from the image buffer 4, corrects it in units of pixels, and writes the corrected image again in the image buffer 4. Note that the operation of the image correction block 10 will be described in detail later with reference to Fig. 10.

In step S7, the saturation calculation block 11 loads the image from the image buffer 4 and calculates saturation values in units of pixels. Also, the saturation parameter setting block 12 determines saturation parameters on the basis of the calculated saturation values, and stores them in the parameter holding block 5. Furthermore, the saturation conversion block 13 corrects saturation in units of pixels on the basis of the saturation conversion parameters stored in the parameter holding block 5, and writes the corrected image again in the image buffer. Note that such saturation correction processes will be explained in detail later with reference to Fig. 12.

In step S8, the image output block 3 reads out the image data stored in the image buffer 4, and outputs it as an output image 14.

[Parameter]

The parameters stored in the parameter holding block 5 will be explained below. Fig. 4 shows register items in the parameter holding block. Referring to

Fig. 4, as parameters for white balance adjustment, a highlight point (LH) of image data, white balance values (RH, GH, BH) for red, green, and blue, a corrected highlight point (HP), and a highlight area value are held. Likewise, as parameters for black balance adjustment, a shadow point (LS) of image data, black balance values for red, green, and blue, a corrected shadow point (SP), and a shadow area value are held.

To implement saturation conversion, a low-saturation side saturation conversion parameter, and a high-saturation side saturation conversion parameter are held. Furthermore, attribute dependent saturation values A, B, and C indicating appropriate saturation values corresponding to individual image attributes are held. In this embodiment, assume that attribute dependent saturation values A, B, and C respectively hold saturation values corresponding to selected attributes, i.e., flesh tone, green of plants, and blue of sky.

In the initial state of this embodiment, these parameters are initialized to appropriate values. For example, "245" is set as the corrected highlight point (HP), and "10" is set as the corrected shadow point (SP). Note that in this embodiment the highlight area ranges from 99 to 100%, and the shadow area from 0 to

1%. Also, for example, the low-saturation side saturation conversion parameter is initialized to "40", and the high-saturation side saturation conversion parameter is initialized to "20".

Moreover, attribute dependent saturation A corresponding to flesh tone is initialized to "0.4", attribute dependent saturation B corresponding to green of plants is initialized to "0.3", and attribute dependent saturation C corresponding to blue of sky is initialized to "0.4". Note that attribute dependent saturation values A, B, and C can be appropriately changed in correspondence with image characteristics, user request, and the like.

[Image Attribute Discrimination Process]

Fig. 5 is a flow chart showing the image attribute discrimination process in the image attribute discrimination block 15. That is, Fig. 5 shows the contents of step S2 in Fig. 3 in detail.

In step S41, the entire image is segmented into a plurality of blocks. For example, the entire image is segmented into a total of 15 blocks = 3 blocks (vertical) × 5 blocks (horizontal). In step S42, image data of one of the segmented blocks is analyzed to set an attribute of that block.

Note that attributes include specific objects such as "person", "flower", and the like, non-objects

such as "sky", "grass", "ground", "general background", and the like, a block, most of which is oversaturated to white (to be referred to as a "white block" hereinafter", an unidentifiable block (to be referred to as "other" hereinafter), and the like. Note that information of such attributes may be pre-stored in, e.g., the ROM 101, or may be stored in the RAM 103, storage unit 8, or the like so that they can be updated. Various methods of discriminating an attribute corresponding to an image block have been proposed, and an attribute may be discriminated using any of such methods. Hence, a detailed description of the discrimination method will be omitted.

Figs. 6A and 6B show examples in which an image is segmented into blocks, and attributes are assigned in units of blocks. Fig. 6A shows an example in which attribute "person" is assigned to the central block of the image, and attribute "other" is assigned to the block underneath that block. Attribute "general background" is assigned to other blocks. In case of this image, the block assigned attribute "person" undergoes saturation conversion so that its saturation becomes "0.4" corresponding to attribute dependent saturation A held in the parameter holding block 5.

In Fig. 6B, attribute "sky" is assigned to the two upper rows of blocks, and in the lowermost row of

blocks attribute "other" is assigned to the two left blocks and attribute "ground" to the three right blocks. In case of this image, the blocks assigned attribute "sky" undergo saturation conversion so that their saturation values become "0.4" corresponding to attribute dependent saturation C held in the parameter holding block 5. Note that saturation conversion in this embodiment will be described in detail later.

It is then checked in step S43 in Fig. 5 if attributes are assigned to all blocks. If NO in step S43, the flow returns to step S42.

[Highlight/Shadow Calculation Process]

Fig. 7 is a flow chart showing the highlight/shadow calculation process in the highlight/shadow calculation block 8. That is, Fig. 7 shows the contents of step S4 in Fig. 3 in detail. Fig. 8 shows an example of the luminance histogram generated in step S3 in Fig. 3.

In step S12, a highlight point LH of the image is calculated on the basis of the luminance histogram shown in Fig. 8. Note that the highlight point LH is the lowest luminance value in the highlight area of the image. Hence, in the luminance histogram example shown in Fig. 8, since the luminance range corresponding to the highlight area (99 to 100%) ranges from 230 to 255, the highlight point LH is "230". This result is stored

in a corresponding register in the parameter holding block 5.

In step S13, a shadow point LS of the image is calculated on the basis of the luminance histogram shown in Fig. 8. Note that the shadow point LS is a highest luminance value in the shadow area of the image. Hence, in the luminance histogram example shown in Fig. 8, since the luminance range corresponding to the shadow area (0 to 1%) ranges from 0 to 14, the shadow point LS is "14". This result is stored in a corresponding register in the parameter holding block 5.

[White/black Balance Calculation Process]

Fig. 9 is a flow chart showing the white/black balance calculation process in the white/black balance calculation block 9. That is, Fig. 9 shows the contents of step S5 in Fig. 3 in detail.

In step S21, white balance values are calculated. More specifically, image data is loaded from the image buffer 4 in units of pixels, and R, G, and B average luminance values (white balance values) of pixels whose luminance values are equal to or higher than the highlight point LH and equal to or lower than a corrected highlight point HP are calculated. In the luminance histogram example shown in Fig. 8, pixels whose luminance values fall within the area ranging from LH = 230 to HP = 245 undergo this process. The

obtained average values are stored in corresponding registers RH, GH, and BH of the parameter holding block 5.

In step S22, black balance values are calculated. More specifically, image data is loaded from the image buffer 4 in units of pixels, and R, G, and B average luminance values (black balance values) of pixels whose luminance values are equal to or higher than a corrected shadow point SP and equal to or lower than the shadow point LS are calculated. In the luminance histogram example shown in Fig. 8, pixels whose luminance values fall within the area ranging from SP = 10 to LS = 14 undergo this process. The obtained average values are stored in corresponding registers RS, GS, and BS of the parameter holding block 5.

[Image Correction Process]

Fig. 10 is a flow chart showing the image correction process in the image correction block 10. That is, Fig. 10 shows the contents of step S6 in Fig. 3 in detail.

In step S31, a look-up table (LUT) is prepared on the basis of the white balance values (RH, GH, BH) of the individual colors, highlight point HP, black balance values (RS, GS, BS), and shadow point LS held in the parameter holding block 5. Fig. 11 shows an example of the prepared LUT. In the LUT shown in

Fig. 11, the highlight portion has steeper gamma correction characteristics in the order of G, B, and R. In this way, by emphasizing G and B with respect to R, so-called color tint of an image tinged with blue (blue cast) can be corrected.

In step S32, the image data stored in the image buffer 4 is corrected in units of pixels on the basis of the prepared LUT.

[Saturation Conversion Process]

Fig. 12 is a flow chart showing the saturation conversion process as the characteristic feature of this embodiment. This process shows the contents of step S7 in Fig. 3 in detail, and is implemented by the saturation calculation block 11, saturation conversion parameter setting block 12, and saturation conversion block 13.

•Color Space Conversion Process

In step S101, the saturation calculation block 11 converts image data expressed in the RGB color space into HLS data in the HLS color space indicating hue, lightness, and saturation. Fig. 13 is a flow chart showing the process for converting RGB data into HLS data in units of pixels, and this process will be explained below. Note that the present invention is not limited to such specific saturation calculation method, and other methods may be used.

Referring to Fig. 13, a maximum value M and minimum value m of R, G, and B color component data of the pixel of interest are obtained (S201). The obtained maximum and minimum values M and m are compared (step S202). If the two values are equal to each other, i.e., if R = G = B and the pixel of interest has achromatic color, the flow advances to step S204. If the two values are not equal to each other, the following values are calculated in step S203:

$$r = (M - R)/(M - m)$$

$$g = (M - G)/(M - m)$$

$$b = (M - B)/(M - m)$$

In step S204, lightness L is calculated by:

$$L = (M + m)/2.0$$

It is checked if the pixel of interest is achromatic color or if lightness L is equal to or lower than a predetermined value (0.5) if the pixel of interest is not achromatic color (S205, S206), and saturation S is calculated according to the discrimination result by (S207 to S209):

Achromatic color : $S = 0$

Chromatic color $L \leq 0.5$: $S = (M-m)/(M+m)$

Chromatic color $L > 0.5$: $S = (M-m)/(2.0-M-m)$

It is then checked if the pixel of interest is achromatic color or which color component the maximum

value M corresponds to if the pixel of interest is not achromatic color (S210, S211), and hue H is calculated according to the discrimination result by (S212 to S216):

Achromatic color : $H' = 0$

Chromatic color R = M : $H' = 2+b-g$

Chromatic color G = M : $H' = 4+r-b$

Chromatic color B = M : $H' = 6+g-r$

$H = 60H'$ (mod360)

Note that the hue of achromatic color is defined to be zero in this embodiment.

As described above, the conversion process shown in Fig. 13 converts RGB data indicating one pixel into HLS data including hue H ranging from 0° to 360° (blue: 0°, red: 120°, green: 240°), lightness L ranging from 0.0 to 1.0 (black to white), and saturation S ranging from 0.0 to 1.0 (achromatic color to most vivid color for certain saturation).

•Load Image Attribute

In step S102 in Fig. 12, image attribute information of each block discriminated by the image attribute discrimination block 7 is loaded from the parameter holding block 5.

•Saturation Conversion Parameter Setup and Saturation Conversion Process

In steps S103 and S104, the saturation conversion parameter setting block 12 determines low- and high-saturation side conversion parameters, and stores them in the parameter holding block 5.

Note that the method of determining the low- and high-saturation side conversion parameters will be described in detail later.

In step S105, the saturation conversion block 13 performs saturation conversion of HLS data of an original image on the basis of the saturation conversion parameters set in steps S103 and S104.

Setups of these two saturation conversion parameters and details of the saturation conversion process using these parameters will be explained below with reference to Fig. 14.

Fig. 14 is a graph showing the saturation conversion characteristics in this embodiment. The abscissa plots the saturation values (0.0 to 1.0) of an original image, and the ordinate plots the converted saturation values (0.0 to 1.0). The abscissa and ordinate respectively also plot low- and high-saturation side conversion parameters, which respectively assume values ranging from 0 to 100, and correspond to conversion lines.

In Fig. 14, if the lower left point of the graph that corresponds to saturation = 0.0 of the original

image and to converted saturation = 0.0 is defined as an origin, for example, a low-saturation side parameter = "0" means a line that connects the origin (0.0, 0.0) and the upper right point (1.0, 1.0) of the graph, and a low-saturation side parameter = "100" means a line that connects the origin (0.0, 0.0) and the upper left point (0.0, 1.0) of the graph. By equally dividing each line into 100 sections, lines corresponding to low-saturation side parameter values ranging from 0 to 100 can be obtained. Hence, when the low-saturation side saturation conversion parameter is, e.g., "40", it indicates a line that connects the origin (0.0, 0.0) and a point (0.6, 1.0).

On the other hand, a high-saturation side parameter = "0" means a line that connects the upper right point (1.0, 1.0) and the origin (0.0, 0.0) of the graph, and a high-saturation side parameter = "100" means a line that connects the upper right point (1.0, 1.0) and the upper left point (0.0, 1.0) of the graph. By equally dividing each line into 100 sections, lines corresponding to high-saturation side parameter values ranging from 0 to 100 can be obtained. Hence, when the high-saturation side saturation conversion parameter is, e.g., "20", it indicates a line that connects the upper right point (1.0, 1.0) and a point (0.0, 0.2) of the graph.

Note that Fig. 14 exemplifies the conversion characteristics that increase saturation. Likewise, conversion characteristics that decrease saturation are available. Fig. 15 shows an example of the conversion characteristics that decrease saturation.

Referring to Fig. 15, the abscissa plots the saturation values (0.0 to 1.0) of an original image, and the ordinate plots the converted saturation values (0.0 to 1.0). The abscissa and ordinate respectively plot high- and low-saturation side conversion parameters, which respectively also assume values ranging from 0 to 100, and correspond to conversion lines.

In Fig. 15, if the lower left point of the graph that corresponds to saturation = 0.0 of the original image and to converted saturation = 0.0 is defined as an origin, for example, a low-saturation side parameter = "0" means a line that connects the origin (0.0, 0.0) and the upper right point (1.0, 1.0) of the graph, and a low-saturation side parameter = "-100" means a line that connects the origin (0.0, 0.0) and the lower right point (1.0, 0.0) of the graph. By equally dividing each line into 100 sections, lines corresponding to low-saturation side parameter values ranging from 0 to -100 can be obtained. Hence, when the low-saturation side saturation conversion parameter is, e.g., "-40",

it indicates a line that connects the origin (0.0, 0.0) and a point (1.0, 0.6).

On the other hand, a high-saturation side parameter = "0" means a line that connects the upper right point (1.0, 1.0) and the origin (0.0, 0.0) of the graph, and a high-saturation side parameter = "-100" means a line that connects the upper right point (1.0, 1.0) and the lower right point (1.0, 0.0) of the graph. By equally dividing each line into 100 sections, lines corresponding to high-saturation side parameter values ranging from 0 to -100 can be obtained. Hence, when the high-saturation side saturation conversion parameter is, e.g., "-20", it indicates a line that connects the upper right point (1.0, 1.0) of the graph and a point (0.2, 0.0).

Note that the saturation conversion characteristics shown in Figs. 14 and 15 may be pre-stored in, e.g., the ROM 101, or may be stored in the RAM 103, storage unit 8, or the like so that they can be updated.

The method of determining low- and high-saturation side conversion parameters in this embodiment will be described below.

In this embodiment, when an image includes a block having image attribute "person", the saturation conversion parameters are set so that the saturation of

that block becomes "0.4" corresponding to attribute dependent saturation A held in the parameter holding block 5. Likewise, when an image includes a block having image attribute "plant" or "sky", the saturation conversion parameters are set so that the saturation of that block becomes "0.3 or "0.4" corresponding to attribute dependent saturation B or C held in the parameter holding block 5.

For example, in Fig. 6(a), if the block assigned image attribute "person" has saturation (e.g., average saturation of pixels in a block) = "0.2", that saturation must be converted into "0.4". In this case, since conversion for increasing saturation is required, a point for converting saturation = "0.2" into "0.4" corresponds to point A (0.2, 0.4) on the graph, as can be seen from the lines shown in Fig. 14. Hence, lines that pass through or are closest to point A are set as the saturation conversion parameters. In this case, since lines B and C pass through the vicinities of point A for low- and high-saturation side saturation conversion parameters, "50" and "30" are respectively set as the low- and high-saturation side saturation conversion parameters in steps S103 and S104.

In Fig. 6(b), when the block assigned image attribute "sky" has saturation = "0.5", that saturation must be converted into "0.4". In this case, since

conversion for decreasing saturation is required, a point for converting saturation = "0.5" into "0.4" corresponds to point E (0.5, 0.4) on the graph, as can be seen from the lines in Fig. 15. Hence, by setting lines that pass through or are closest to point E as the saturation conversion parameters, "-20" corresponding to lines F and G are respectively set as the low- and high-saturation side saturation conversion parameters in steps S103 and S104.

On the other hand, if an image includes none of blocks having image attributes "person", "plant", "sky", and the like, i.e., if an image has no blocks corresponding to the attribute dependent saturation values held in the parameter holding block 5, default values "40" and "20" are respectively set as the low- and high high-saturation side saturation conversion parameters in steps S103 and S104.

Based on the two, low- and high-saturation side conversion lines set in this manner, saturation conversion characteristics actually used in the saturation conversion process are calculated. For example, in Fig. 14, when "50" and "30" are respectively set as the low- and high-saturation side saturation conversion parameters, the two corresponding lines cross at point D. Hence, in step S105, a line that connects the origin (0.0, 0.0), point D, and the

upper right point (1.0, 1.0) of the graph is calculated as the saturation conversion characteristics, and the saturation (S) component of the HLS data converted in step S101 undergoes saturation conversion based on the calculated characteristics. According to the saturation conversion characteristics, the converted saturation neither becomes 0.0 (achromatic color) nor is saturated at 1.0.

In this manner, since different saturation parameters can be set at the low- and high-saturation sides, oversaturation or undersaturation due to saturation conversion can be avoided, and appropriate saturation correction can be achieved at both sides.

•Inverse Color Space Conversion Process

After the HLS data has undergone saturation conversion, the saturation calculation block 11 inversely converts the saturation-converted HLS data into RGB data in step S106 in Fig. 12. Fig. 16 is a flow chart showing the inverse conversion process from HLS data into RGB data, and this process will be explained below.

Referring to Fig. 16, it is checked if a lightness value L is equal to or higher than a predetermined value (0.5) (S301). If YES in step S301, parameter M = L(1.0 + S) is set (S302); otherwise, M = L + S - LS is set (S303). After parameter m = 2.0L - M

is set (S304), R, G, and B color component values are calculated using a function f(m, M, h) by (S305):

$$R = f(m, M, H)$$

$$G = f(m, M, H-120)$$

$$B = f(m, M, H-240)$$

Note that depending on the value h, the function f(m, M, h) is determined by:

$$0 \leq h < 60 \quad : f(m, M, h) = m+(M-m)h/60$$

$$60 \leq h < 180 \quad : f(m, M, h) = M$$

$$180 \leq h < 240 \quad : f(m, M, h) = m+(M-m)(240-h)/60$$

$$240 \leq h < 360 \quad : f(m, M, h) = m$$

Note that if h is a negative value, a value obtained by adding 360 to h is referred to.

In this manner, the saturation-converted HLS data is inversely converted into RGB data, and the converted data is held in the buffer 4. Then, the RGB data is output as an output image 14 (S8).

In this embodiment, the default value of the low-saturation side saturation conversion parameter is set at "40", and that of the high-saturation side saturation conversion parameter is set at "20". However, the present invention is not limited to such specific default values of the parameters, and any other values may be set if they fall within an allowable setting range (0 to 100 in the above embodiment).

Furthermore, the saturation conversion parameters may be directly set according to user instruction. More specifically, the user may change the parameters set by the saturation conversion parameter setting block 12 via the keyboard I/F 109. For example, the user may directly designate an image attribute, and the saturation conversion parameters may be set in correspondence with the designated image attribute.

As shown in Figs. 14 and 15, in this embodiment, the saturation conversion parameters correspond to saturation conversion lines. However, the saturation conversion characteristics of the present invention are not limited to lines but may be defined by curves. That is, appropriate lines or curves need only be set as saturation conversion characteristics so as to achieve appropriate saturation conversion.

As described above, according to this embodiment, since an image attribute is discriminated, and the saturation conversion characteristics can be set in correspondence with the discrimination result, optimal saturation conversion can be implemented in accordance with the image attribute. Especially, saturation conversion can be satisfactorily made in correspondence with memory color such as flesh tone of a human being, and the like that a person notices and reacts sensitively to their delicate conversion results.

Since the saturation conversion characteristics can vary at the low- and high-saturation sides, flexible saturation conversion can be attained, and chromatic color can be prevented from becoming achromatic at the low-saturation side or being saturated at the high-saturation side as a result of saturation conversion.

<Modification>

In the above embodiment, only one of attributes "person", "plant", and "sky" appears in the image to be converted. However, two or more image attributes (e.g., "person" and "sky") are highly likely to be assigned to one image. In such case, no problem is posed if a saturation conversion parameter common to the plurality of attributes can be set, and saturation conversion which can satisfy all the assigned attributes can be achieved.

However, if a common saturation conversion parameter cannot be set, priority must be set among attributes. For example, priority may be set in the order of "person" > "sky" > "plant". Of course, the present invention is not limited to such specific priority order, and priority can be arbitrarily set in correspondence with the type of scene of an image, the image forming situation in the image processing apparatus, or user request.

In the above embodiment, three different attributes "person", "plant", and "sky" are weighted upon saturation conversion, and attribute dependent saturation values corresponding to these attributes are held in the parameter holding block 5. However, attribute dependent saturation values corresponding to other attributes such as "sea" and the like may be added to the parameter holding block 5.

Furthermore, attribute "person" which corresponds to flesh tone may be divided into "white race", "black race", "yellow race", and the like, and attribute "sky" may be divided into "cloudy", "fine" "evening glow", "night sky", and the like, and corresponding attribute dependent saturation values may be added. That is, optimal saturation values corresponding to individual attributes can be set in the parameter holding block 5.

The number of segmented blocks upon image attribute discrimination is not limited to 3 × 5 blocks in the above embodiment. For example, the image may be segmented into still smaller blocks such as 5 × 7 blocks and the like, or the number of segmented blocks may be adaptively determined in consideration of the aspect ratio of an image. Furthermore, the shape of one block is not limited to a rectangular shape, but may be a triangular shape, hexagonal shape, trapezoidal shape, and the like.

In the above embodiment, the saturation conversion parameters are set so that the average saturation of pixel in a given block assigned a predetermined attribute becomes a predetermined value. Alternatively, a principal object in a given block may be extracted by a known recognition technique, and the saturation conversion parameter may be set based on the average saturation of only pixels that form the principal object. In this manner, correction which is free from any influences of the background and is optimal to the principal object can be achieved.

[Other Embodiments]

Note that the present invention may be applied to either a system constituted by a plurality of devices (e.g., a host computer, an interface device, a reader, a printer, and the like), or an apparatus consisting of a single equipment (e.g., a copying machine, a facsimile apparatus, or the like).

The objects of the present invention are also achieved by supplying a storage medium, which records a program code of a software program that can implement the functions of the above-mentioned embodiments to the system or apparatus, and reading out and executing the program code stored in the storage medium by a computer (or a CPU or MPU) of the system or apparatus. In this case, the program code itself read out from the storage

medium implements the functions of the above-mentioned embodiments, and the storage medium which stores the program code constitutes the present invention. As the storage medium for supplying the program code, for example, a floppy disk, hard disk, optical disk, magneto-optical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, ROM, and the like may be used.

The functions of the above-mentioned embodiments may be implemented not only by executing the readout program code by the computer but also by some or all of actual processing operations executed by an OS (operating system) running on the computer on the basis of an instruction of the program code.

Furthermore, the functions of the above-mentioned embodiments may be implemented by some or all of actual processing operations executed by a CPU or the like arranged in a function extension board or a function extension unit, which is inserted in or connected to the computer, after the program code read out from the storage medium is written in a memory of the extension board or unit.

When the present invention is applied to the storage medium, that storage medium stores program codes corresponding to the aforementioned flow charts (Figs. 3, 5, 7, 9, 10, 12, 13, and 16).

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

WHAT IS CLAIMED IS:

1. An image processing apparatus comprising:

characteristic discrimination means for discriminating characteristics of an image;

saturation calculation means for calculating saturation information of the image;

parameter setting means for setting a parameter used to convert saturation of the image in accordance with the characteristics discriminated by said characteristic discrimination means; and

saturation conversion means for converting the saturation of the image on the basis of the parameter.

2. The apparatus according to claim 1, wherein said characteristic discrimination means discriminates one of a plurality of attributes to which the image belongs.

3. The apparatus according to claim 2, wherein the attribute is a color attribute of an image.

4. The apparatus according to claim 2, wherein the attribute is set in correspondence with an object in an image.

5. The apparatus according to claim 4, wherein the attribute includes at least one of attributes "person", "flower", "sky", "grass", "ground", and "general background".

6. The apparatus according to claim 5, wherein the attribute further includes an attribute "white"

indicating that a content of an image is substantially white.

7. The apparatus according to claim 6, wherein the attribute further includes an attribute "other" which does not belong to any other attributes.

8. The apparatus according to claim 1, further comprising:

holding means for holding saturation information in correspondence with the plurality of attributes, wherein

said parameter setting means sets the parameter on the basis of the saturation information held in said holding means.

9. The apparatus according to claim 8, wherein said holding means holds optimal saturation values in units of attributes.

10. The apparatus according to claim 9, wherein said parameter setting means sets the parameter to convert saturation of a color indicated by the attribute in the image into a saturation value held in said holding means.

11. The apparatus according to claim 2, wherein said characteristic discrimination means segments the image into a plurality of blocks, and discriminates attributes in units of blocks.

12. The apparatus according to claim 11, wherein said parameter setting means sets the parameter on the basis of an attribute with high priority when attributes differ in units of blocks.

13. The apparatus according to claim 1, wherein said parameter setting means sets a plurality of parameters.

14. The apparatus according to claim 13, wherein said parameter setting means sets the parameters in correspondence with low- and high-saturation sides of the image.

15. The apparatus according to claim 13, wherein said saturation conversion means determines saturation conversion characteristics on the basis of the plurality of parameters, and converts saturation of the image on the basis of the saturation conversion characteristics.

16. The apparatus according to claim 15, wherein said saturation conversion means determines the saturation conversion characteristics on high- and low-saturation sides of the image on the basis of the plurality of parameters.

17. The apparatus according to claim 16, wherein the saturation conversion characteristics exhibit a monotonous increase.

18. The apparatus according to claim 16, wherein the saturation conversion characteristics exhibit a monotonous decrease.

19. The apparatus according to claim 1, wherein said saturation calculation means calculates saturation information of the image by converting the image expressed in a first color space into a second color space.

20. The apparatus according to claim 19, wherein said saturation calculation means further converts the image, which has been saturation-converted in the second color space by said saturation conversion means, into the first color space.

21. The apparatus according to claim 19, wherein the first color space is an RGB color space, and the second color space is an HLS color space.

22. The apparatus according to claim 1, further comprising:

detection means for detecting a color distribution of the image;

generation means for generating gradation correction information of the image on the basis of the color distribution; and

gradation correction means for performing gradation correction of the image on the basis of the gradation correction information.

23. The apparatus according to claim 22, wherein said saturation conversion means performs saturation conversion for an image which has undergone the gradation correction by said gradation correction means.

24. The apparatus according to claim 22, wherein said generation means comprises:

highlight calculation means for calculating highlight area information of an image on the basis of the color distribution; and

white balance calculation means for calculating white balance information on the basis of the highlight area information and a predetermined highlight value, and

said gradation correction means corrects gradation of the image on the basis of the white balance information and the highlight value.

25. The apparatus according to claim 22, wherein said generation means comprises:

shadow calculation means for calculating shadow area information of an image; and

black balance calculation means for calculating black balance information on the basis of the shadow area information and a predetermined shadow value, and

said gradation correction means corrects gradation of the image on the basis of the black balance information and the shadow value.

26. An image processing method comprising:

the characteristic discrimination step of discriminating characteristics of an image;

the saturation calculation step of calculating saturation information of the image;

the parameter setting step of setting a parameter used to convert saturation of the image in accordance with the characteristics discriminated in the characteristic discrimination step; and

the saturation conversion step of converting the saturation of the image on the basis of the parameter.

27. The method according to claim 26, wherein the characteristic discrimination step includes the step of discriminating one of a plurality of attributes to which the image belongs.

28. The method according to claim 27, wherein the attribute is a color attribute of an image.

29. The method according to claim 27, wherein the parameter setting step includes the step of setting the parameter to convert saturation of a color indicated by the attribute in the image into a saturation value which is set in advance in units of attributes.

30. The method according to claim 27, wherein the characteristic discrimination step includes the step of segmenting the image into a plurality of blocks, and discriminating attributes in units of blocks.

31. The method according to claim 26, wherein the parameter setting step includes the step of setting parameters in correspondence with low- and high-saturation sides of the image.

32. A recording medium comprising program codes of an image processing method at least comprising:

a code of the characteristic discrimination step of discriminating characteristics of an image;

a code of the saturation calculation step of calculating saturation information of the image;

a code of the parameter setting step of setting a parameter used to convert saturation of the image in accordance with the characteristics discriminated in the characteristic discrimination step; and

a code of the saturation conversion step of converting the saturation of the image on the basis of the parameter.

ABSTRACT OF THE INVENTION

When saturation conversion is done by multiplying data by a saturation conversion parameter with a constant value regardless of image features, an image which can give good impression to the user cannot always be obtained.

In this invention, an image is segmented into a predetermined number of blocks, and attributes are discriminated in units of blocks. Conversion characteristics are calculated on the basis of saturation conversion parameters of an image, which are set in correspondence with the discrimination result, and saturation is converted based on the calculated characteristics. In this way, appropriate saturation correction can be achieved in correspondence with the image attribute.

FIG. 1

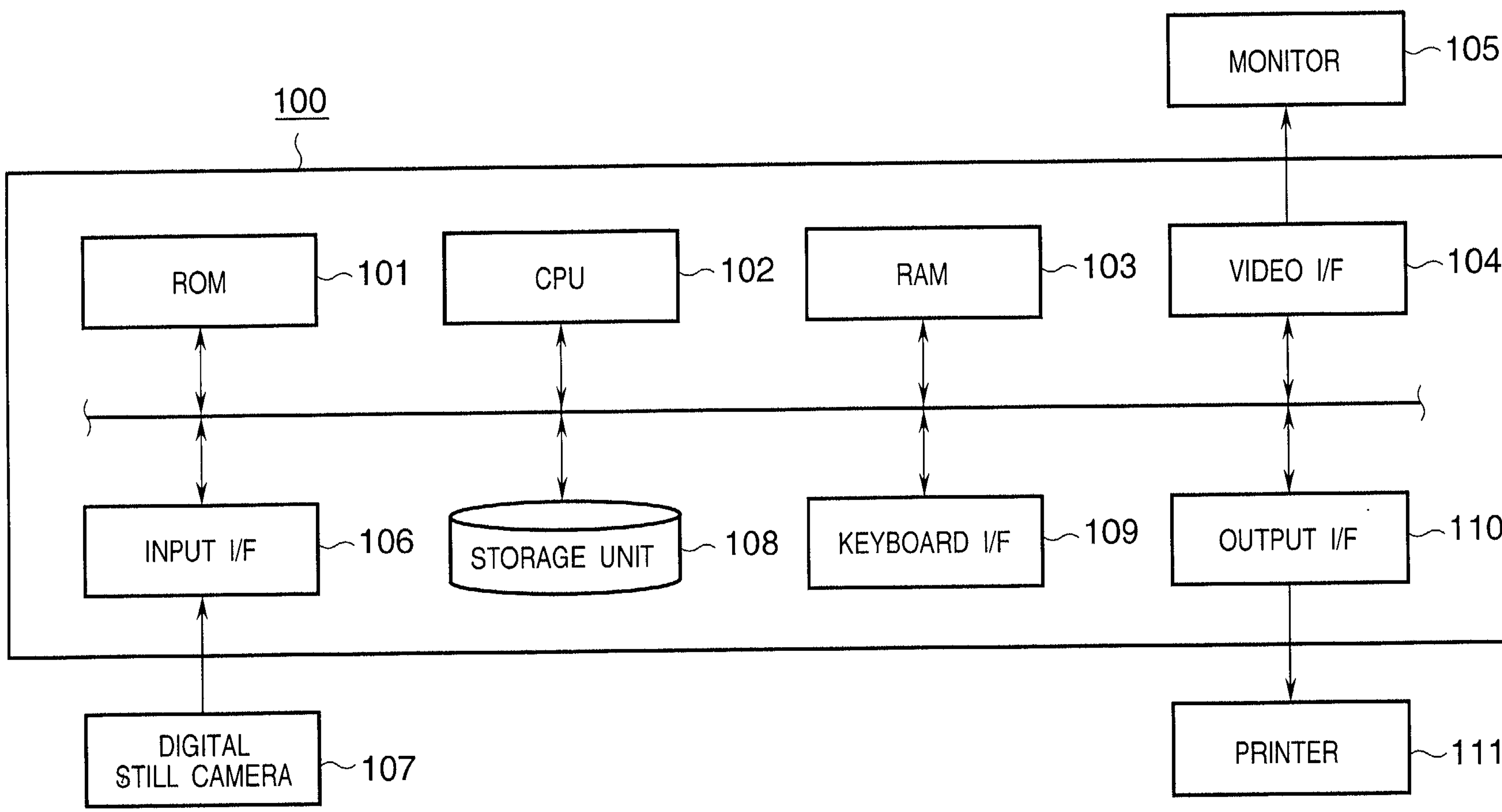

100
ROM
101
CPU
102
RAM
103
VIDEO I/F
104
MONITOR
105
INPUT I/F
106
DIGITAL
STILL CAMERA
107
STORAGE UNIT
108
KEYBOARD I/F
109
OUTPUT I/F
110
PRINTER
111

FIG. 2

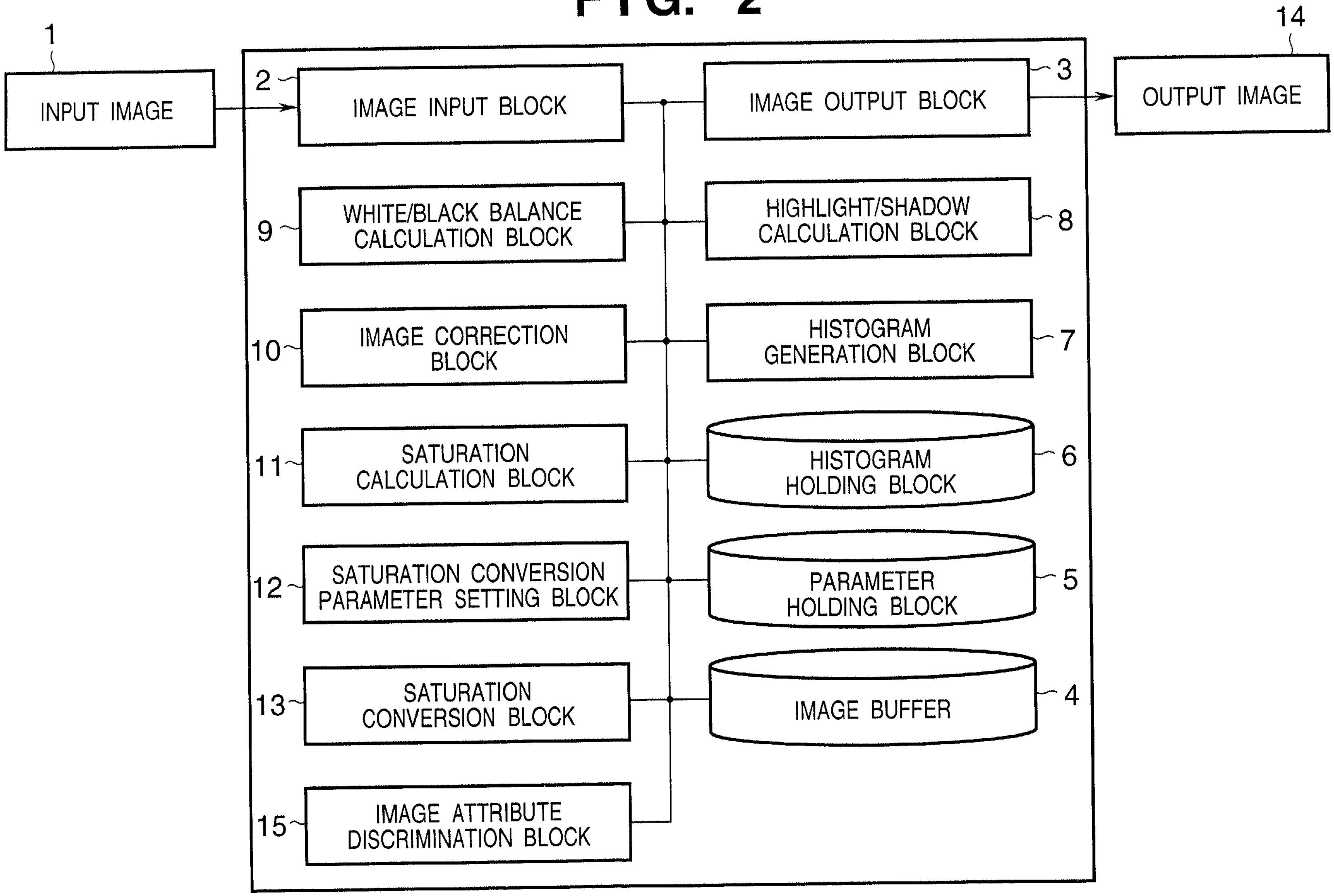

1
INPUT IMAGE
2
IMAGE INPUT BLOCK
3
IMAGE OUTPUT BLOCK
14
OUTPUT IMAGE
9
WHITE/BLACK BALANCE CALCULATION BLOCK
8
HIGHLIGHT/SHADOW CALCULATION BLOCK
10
IMAGE CORRECTION BLOCK
7
HISTOGRAM GENERATION BLOCK
11
SATURATION CALCULATION BLOCK
6
HISTOGRAM HOLDING BLOCK
12
SATURATION CONVERSION PARAMETER SETTING BLOCK
5
PARAMETER HOLDING BLOCK
13
SATURATION CONVERSION BLOCK
4
IMAGE BUFFER
15
IMAGE ATTRIBUTE DISCRIMINATION BLOCK

FIG. 3

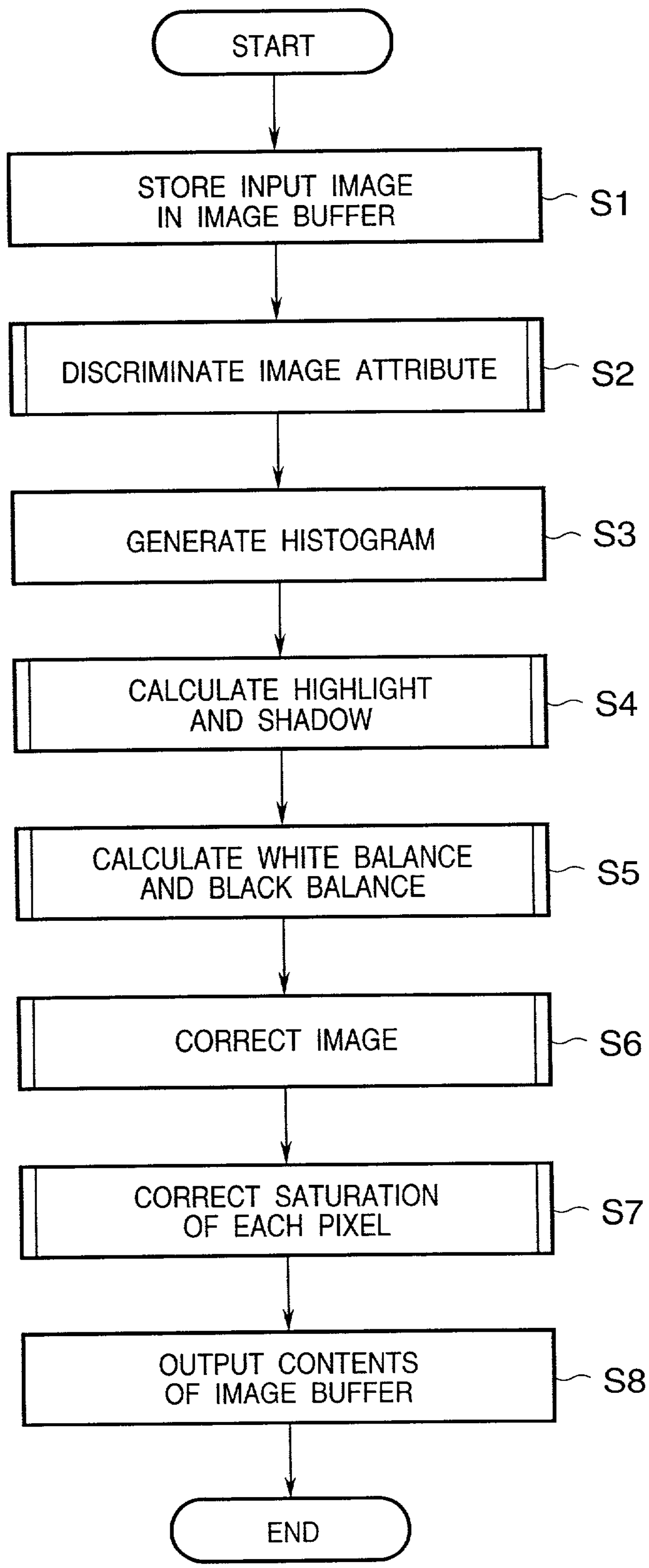

START
STORE INPUT IMAGE IN IMAGE BUFFER
S1
DISCRIMINATE IMAGE ATTRIBUTE
S2
GENERATE HISTOGRAM
S3
CALCULATE HIGHLIGHT AND SHADOW
S4
CALCULATE WHITE BALANCE AND BLACK BALANCE
S5
CORRECT IMAGE
S6
CORRECT SATURATION OF EACH PIXEL
S7
OUTPUT CONTENTS OF IMAGE BUFFER
S8
END

FIG. 4

ITEM	VALUE
HIGHLIGHT POINT OF IMAGE(LH)	###
WHITE BALANCE RED(RH)	###
WHITE BALANCE GREEN(GH)	###
WHITE BALANCE BLUE(BH)	###
CORRECTED HIGHLIGHT POINT(HP)	###
HIGHLIGHT AREA	##%~##%
SHADOW POINT OF IMAGE(LS)	###
BLACK BALANCE RED(RS)	###
BLACK BALANCE GREEN(GS)	###
BLACK BALANCE BLUE(BS)	###
CORRECTED SHADOW POINT(SP)	###
SHADOW AREA	##%~##%
LOW-SATURATION SIDE SATURATION CONVERSION PARAMETER	###
HIGH-SATURATION SIDE SATURATION CONVERSION PARAMETER	###
ATTRIBUTE DEPENDENT SATURATION A (FLESH TONE)	###
ATTRIBUTE DEPENDENT SATURATION B (GREEN OF PLANT)	###
ATTRIBUTE DEPENDENT SATURATION C (BLUE OF SKY)	###

FIG. 5

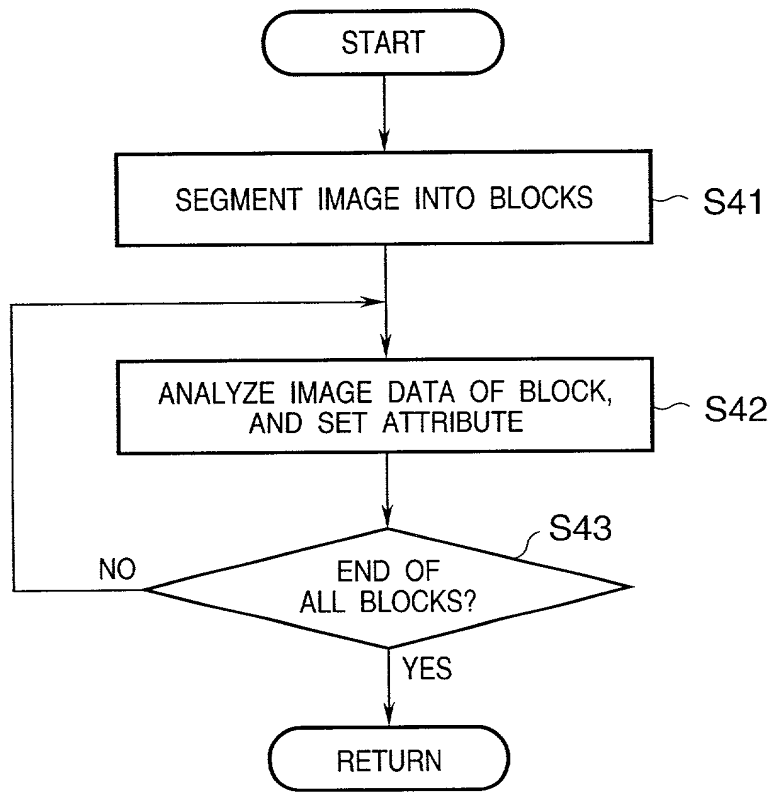

START
SEGMENT IMAGE INTO BLOCKS
S41
ANALYZE IMAGE DATA OF BLOCK, AND SET ATTRIBUTE
S42
S43
END OF ALL BLOCKS?
NO
YES
RETURN

FIG. 6A

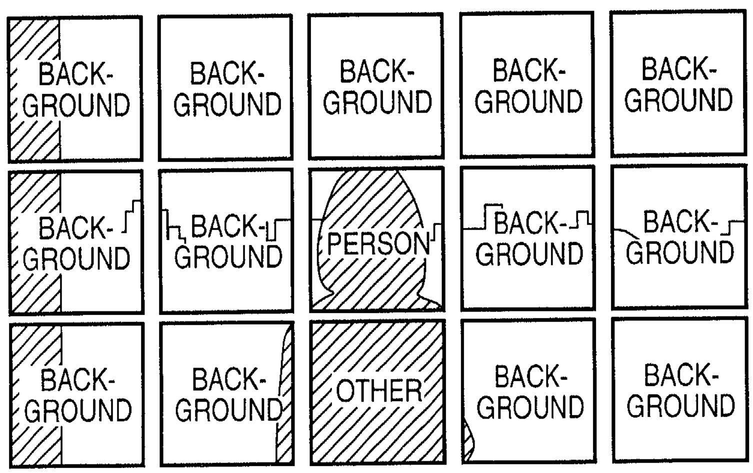

BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
PERSON
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
BACK-
GROUND
OTHER
BACK-
GROUND
BACK-
GROUND

FIG. 6B

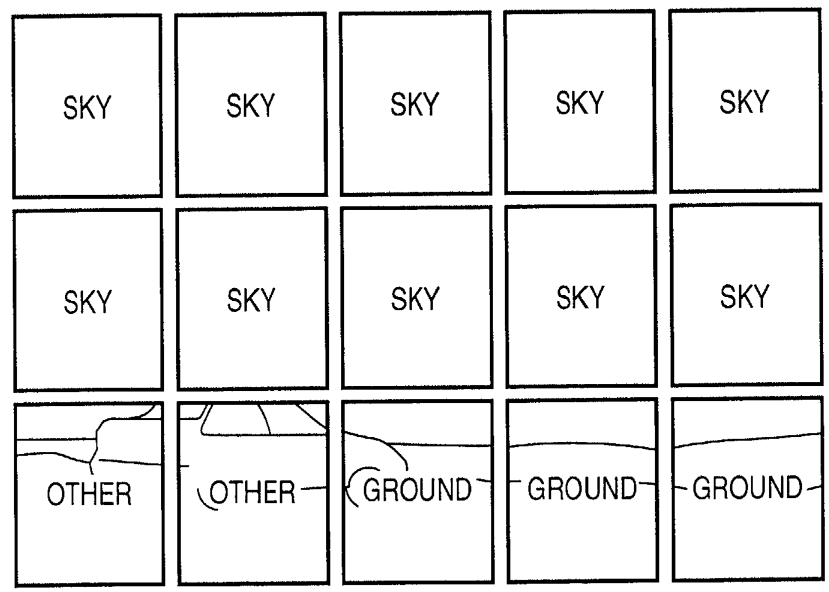

SKY
SKY
SKY
SKY
SKY
SKY
SKY
SKY
SKY
SKY
OTHER
OTHER
GROUND
GROUND
GROUND

FIG. 7

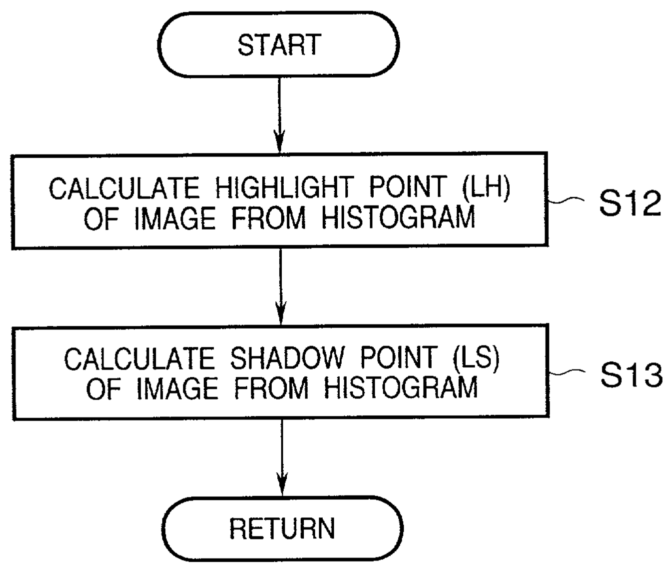

START
CALCULATE HIGHLIGHT POINT (LH) OF IMAGE FROM HISTOGRAM
S12
CALCULATE SHADOW POINT (LS) OF IMAGE FROM HISTOGRAM
S13
RETURN

FIG. 8

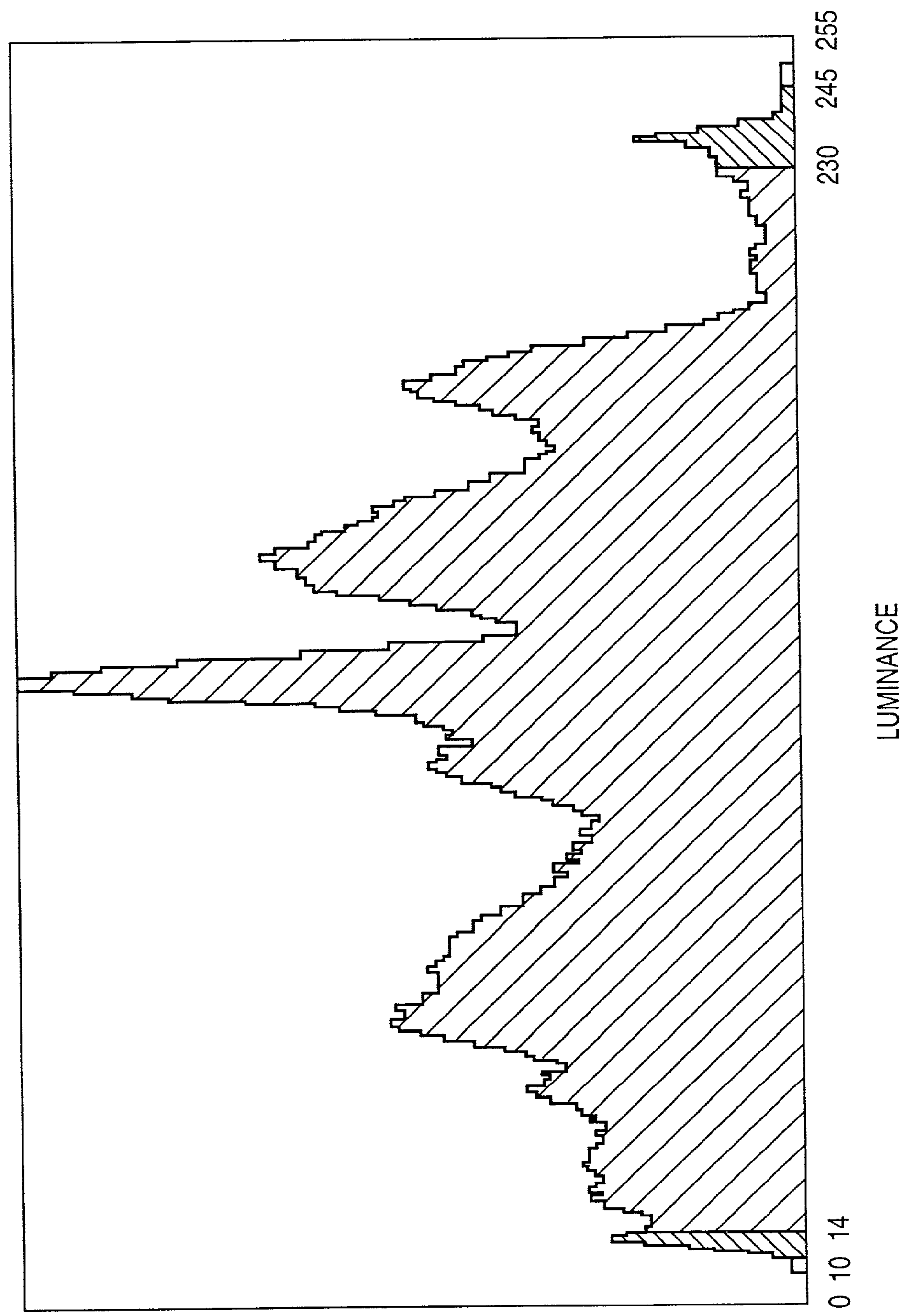


FIG. 9

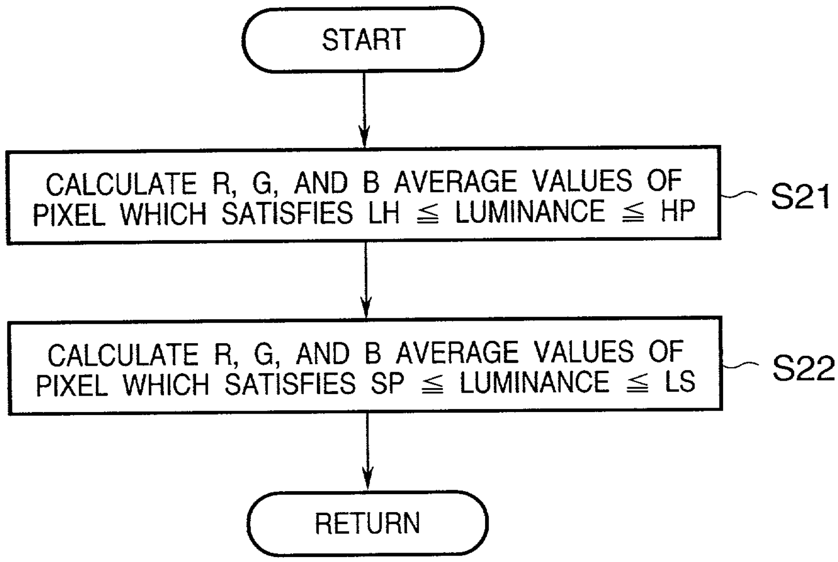

START
CALCULATE R, G, AND B AVERAGE VALUES OF PIXEL WHICH SATISFIES LH ≦ LUMINANCE ≦ HP
S21
CALCULATE R, G, AND B AVERAGE VALUES OF PIXEL WHICH SATISFIES SP ≦ LUMINANCE ≦ LS
S22
RETURN

FIG. 10

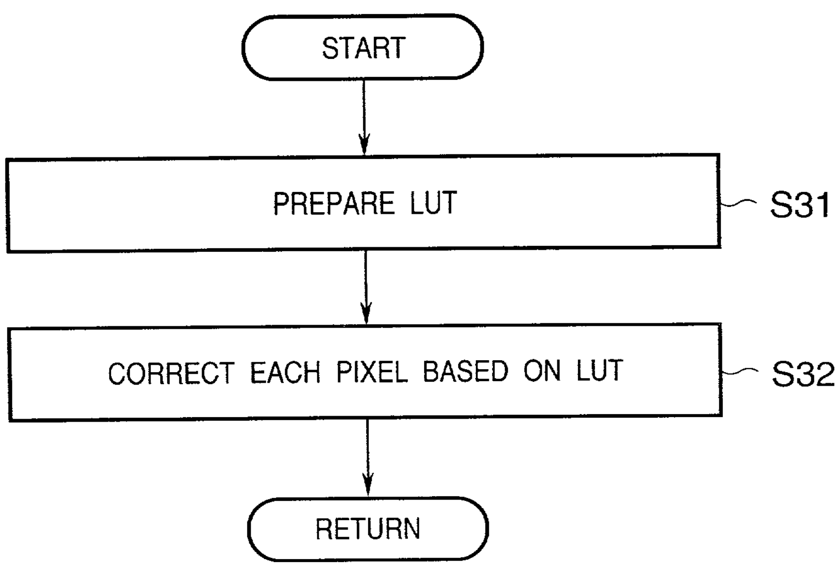

START
PREPARE LUT
S31
CORRECT EACH PIXEL BASED ON LUT
S32
RETURN

FIG. 11

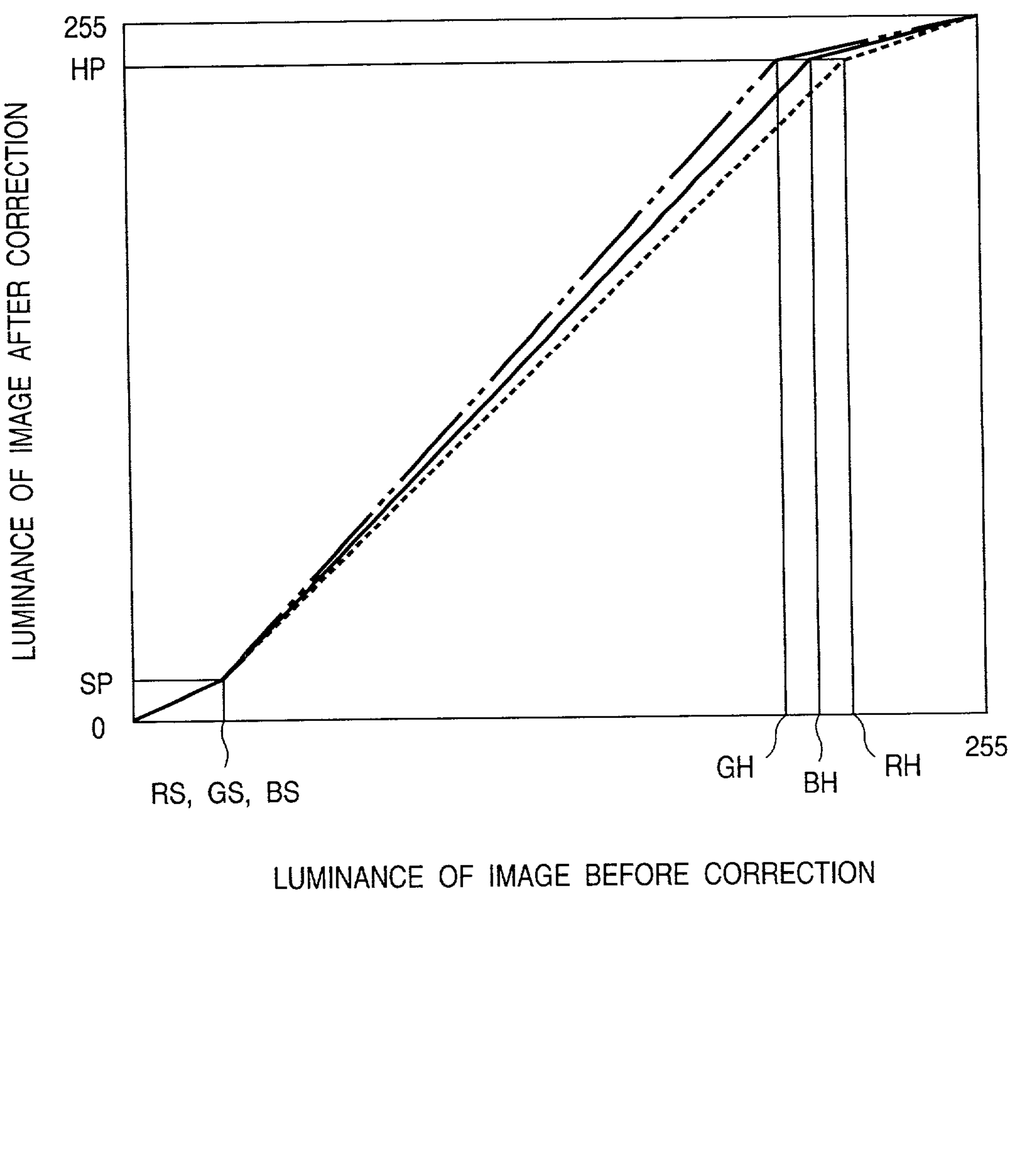

255
HP
SP
0
LUMINANCE OF IMAGE AFTER CORRECTION
RS, GS, BS
GH
BH
RH
255
LUMINANCE OF IMAGE BEFORE CORRECTION

FIG. 12

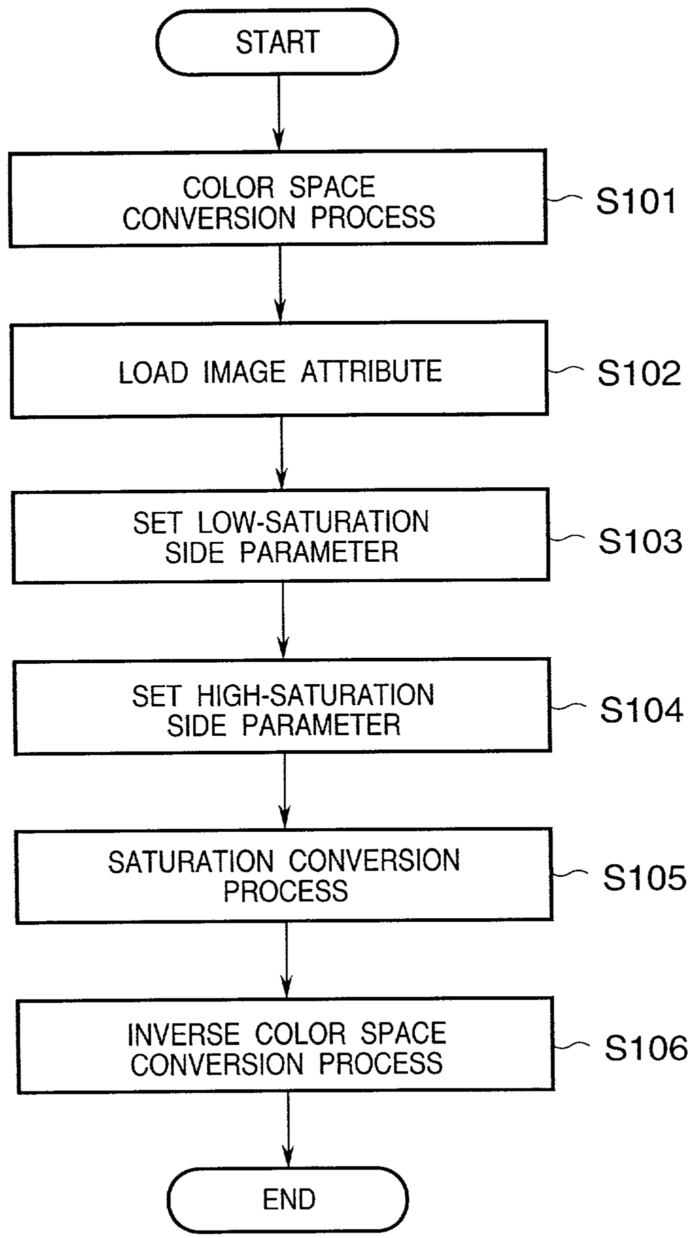

START
COLOR SPACE CONVERSION PROCESS
S101
LOAD IMAGE ATTRIBUTE
S102
SET LOW-SATURATION SIDE PARAMETER
S103
SET HIGH-SATURATION SIDE PARAMETER
S104
SATURATION CONVERSION PROCESS
S105
INVERSE COLOR SPACE CONVERSION PROCESS
S106
END

FIG. 13

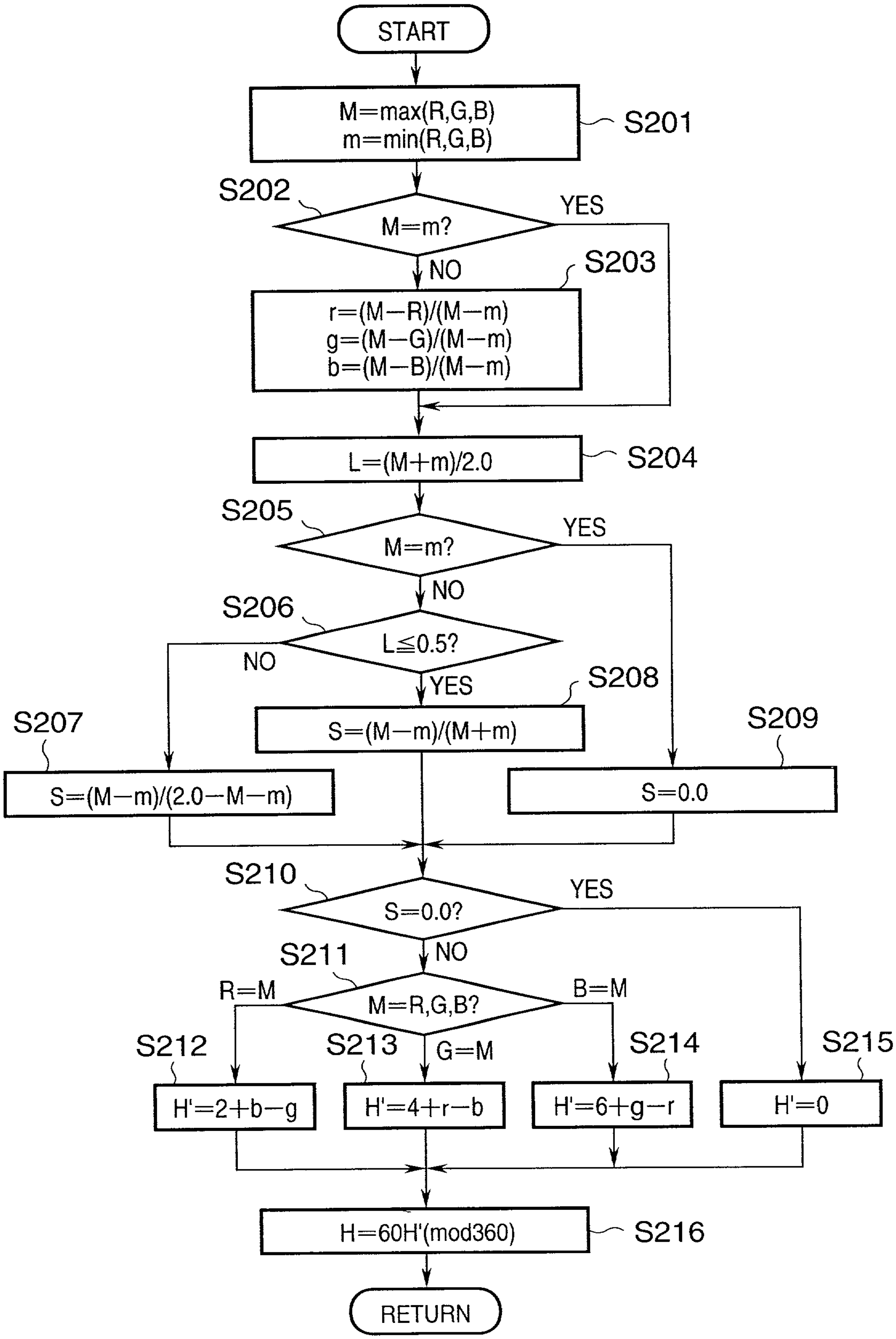

START
M=max(R,G,B)
m=min(R,G,B)
S201
S202
M=m?
YES
NO
S203
r=(M−R)/(M−m)
g=(M−G)/(M−m)
b=(M−B)/(M−m)
L=(M+m)/2.0
S204
S205
M=m?
YES
NO
S206
L≦0.5?
NO
YES
S208
S=(M−m)/(M+m)
S207
S=(M−m)/(2.0−M−m)
S209
S=0.0
S210
S=0.0?
YES
NO
S211
R=M
M=R,G,B?
B=M
G=M
S212
H'=2+b−g
S213
H'=4+r−b
S214
H'=6+g−r
S215
H'=0
H=60H'(mod360)
S216
RETURN

FIG. 14

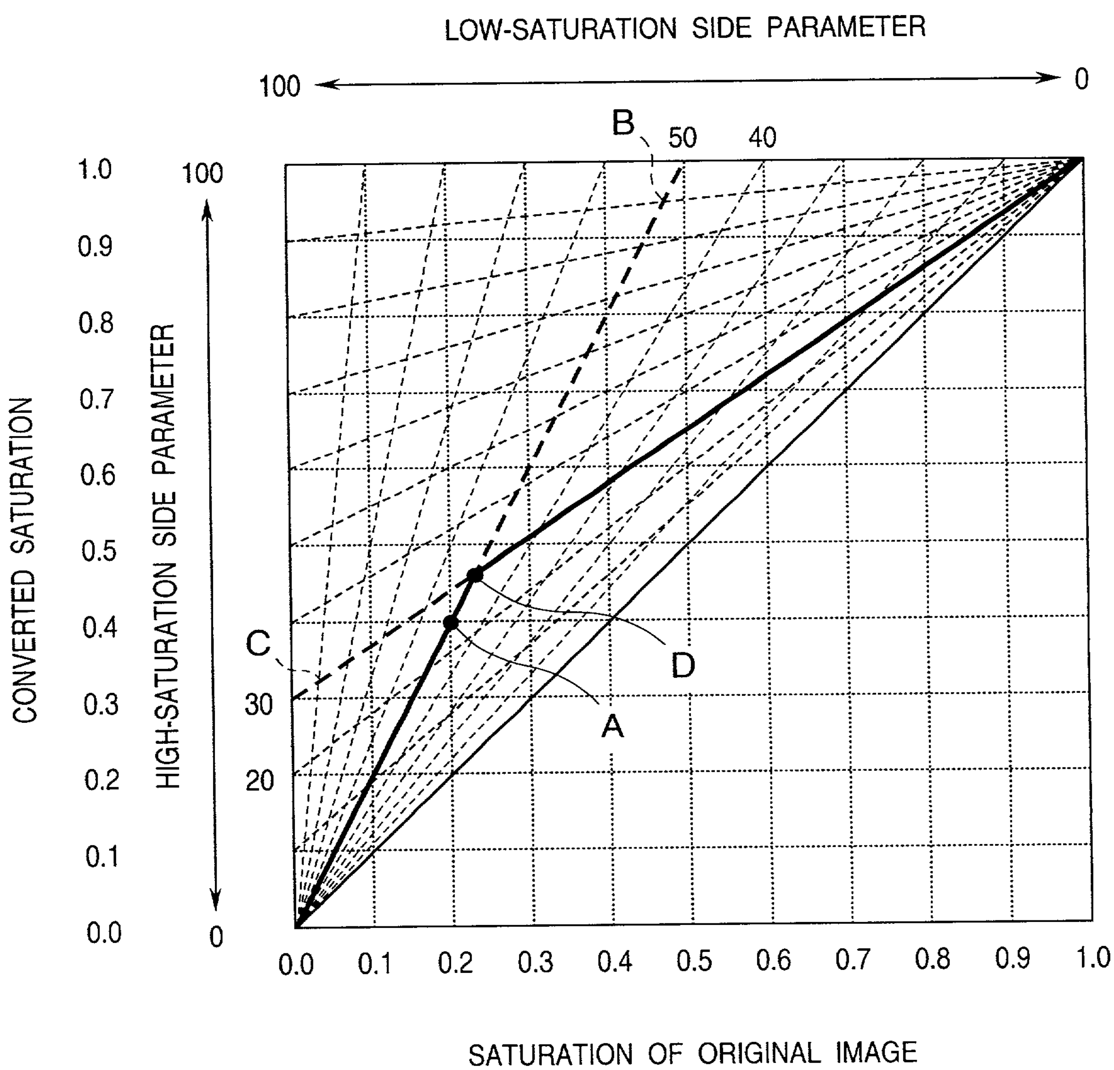

LOW-SATURATION SIDE PARAMETER
100
0
B
50
40
C
D
A
30
20
CONVERTED SATURATION
HIGH-SATURATION SIDE PARAMETER
100
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
SATURATION OF ORIGINAL IMAGE

FIG. 15

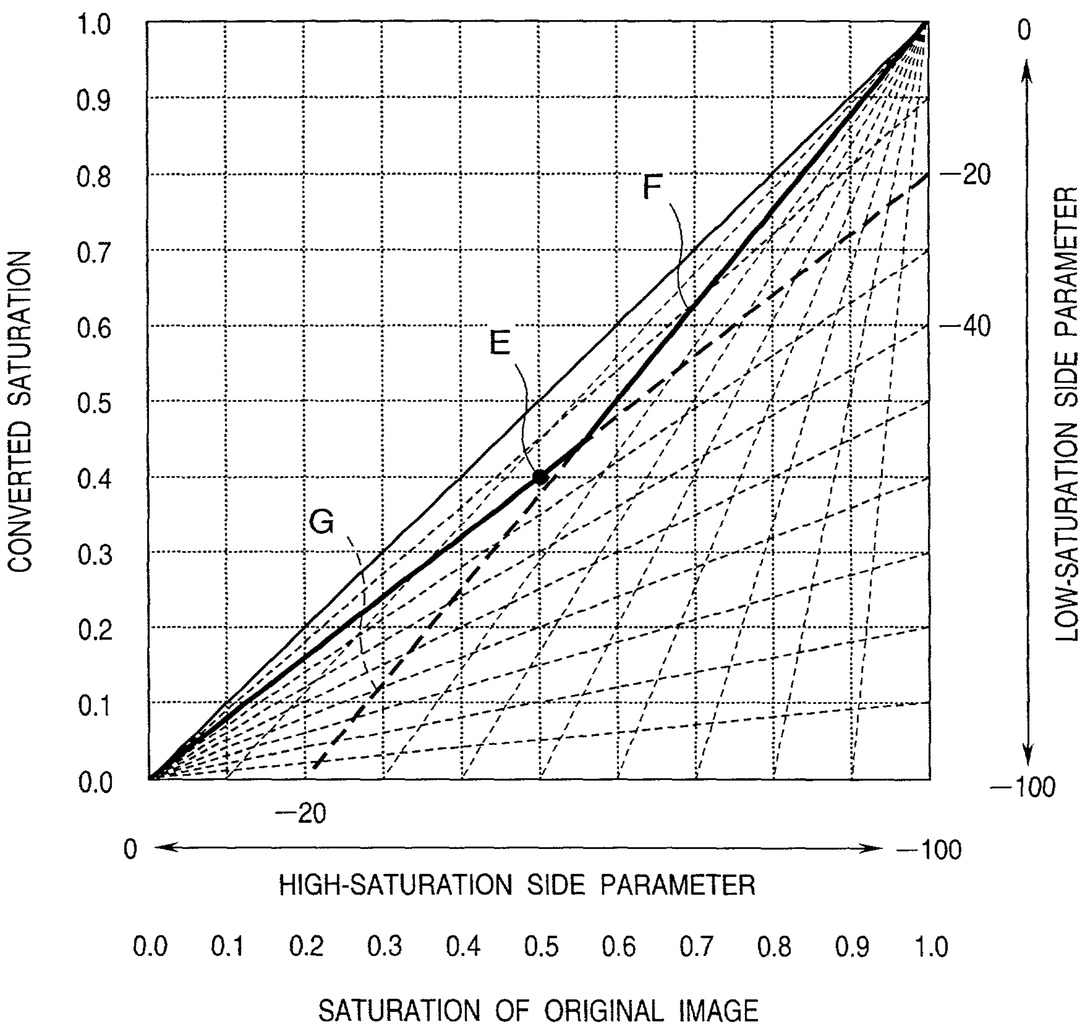
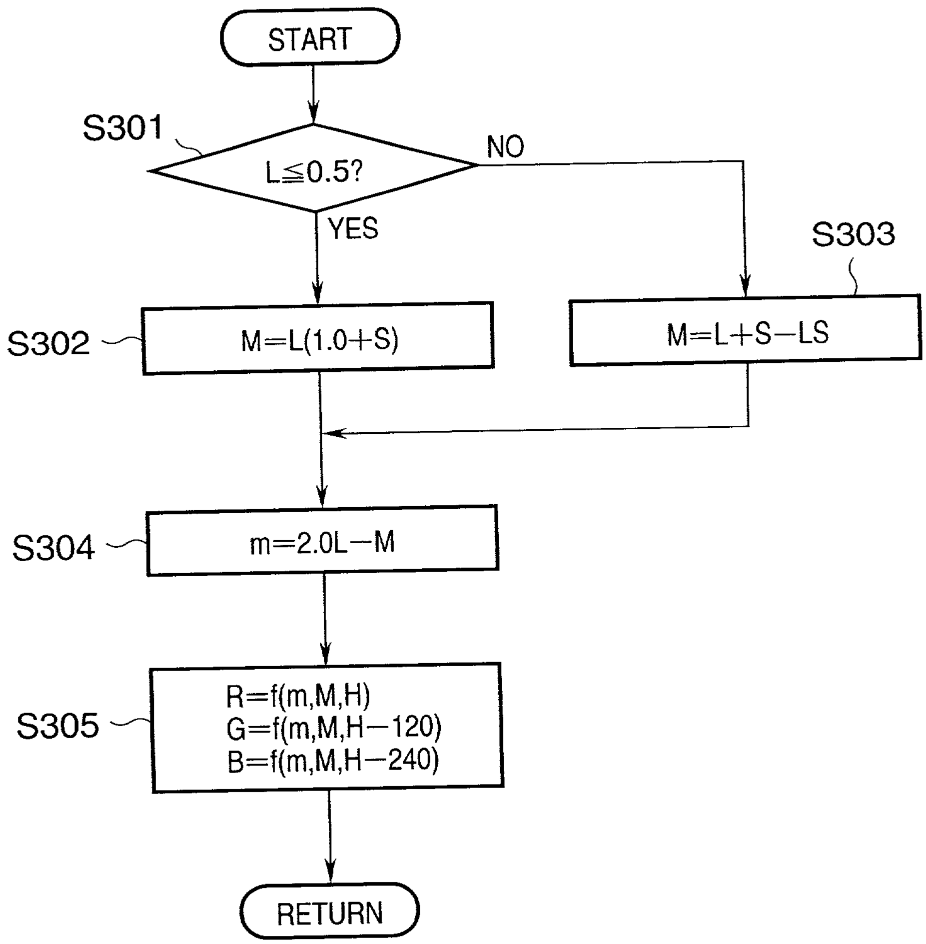

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CONVERTED SATURATION
F
E
G
0
−20
−40
−100
LOW-SATURATION SIDE PARAMETER
−20
0
−100
HIGH-SATURATION SIDE PARAMETER
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
SATURATION OF ORIGINAL IMAGE

FIG. 16


START
S301
L≦0.5?
NO
YES
S302
M=L(1.0+S)
S303
M=L+S−LS
S304
m=2.0L−M
S305
R=f(m,M,H)
G=f(m,M,H−120)
B=f(m,M,H−240)
RETURN

COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled IMAGE PROCESSING APPARATUS AND METHOD, AND RECORDING MEDIUM

the specification of which [X] is attached hereto [ ] was filed on ______ as United States Application No. or PCT International Application No. ______ and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

Country	Application No.	Filed (Day/Mo./Yr.)	(Yes/No) Priority Claimed
Japan	10-297284	19 October 1998	Yes

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Application No.	Filed (Day/Mo./Yr.)	Status (Patented, Pending, Abandoned)

I hereby appoint the practitioners associated with the firm and Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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